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With international search report.

(54) Title: IMPROVED FERTILISER

(57) Abstract

A phosphatic fertiliser having improved efficacy and resistance to leaching, is produced by intimately admixing superphosphate and lime in the dry state, in the proportion of not less than one part by weight of lime to one part by weight of superphosphate, the particle size of superphosphate having been reduced to below 250 microns and the particle size of lime having been reduced to below 72 microns prior to mixing. Water is then added to the mixture causing a chemical reaction to occur between the lime and superphosphate, such that on completion of the chemical reaction, the fertilizer contains phosphate which is substantially insoluble in water but which is citrate soluble and contains an excess of lime. The resulting fertiliser has a pH of not less than 7. The fertiliser may be formed into pallets utilising any suitable binder. A process of producing the fertiliser and a plant for manufacturing same are described.

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IMPROVED FERTILISER

This invention relates to the use of phosphatic fertilisers, and in particular superphosphates, especially when used in soils where the prevailing conditions tend to promote acidity. The invention particularly relates to the pelletising of such fertilisers, as well as the preparation of such fertilisers in powder form.

Phosphatic fertilisers and especially superphosphates, have long been recognised as especially suitable fertilisers in Australia and elsewhere for cereal grain crops, hay crops, fodder crops, pastures in general, orchards, vegetables and for other general horticultural purposes.

Superphosphate is produced by the reaction of phosphoric acid and sulphuric acid on phosphate containing rock to give calcium sulphate $CaSO_4$ and calcium dihydrogen phosphate $Ca(H_2PO_4)_2$. For convenience, however the following description refers to superphosphates as a generic term for all the phosphatic fertilisers including single, double and triple superphosphate as well as any other phosphatic fertiliser. No limitation to superphosphates alone is intended or should be inferred.

There are enormous problems in the use of superphosphate in large areas of Australia and other countries, by virtue of the prevalence of so-called acid soils. Significant reductions in the efficacy of superphosphates are caused by virtue of the fact that the superphosphates are water soluble, particularly in acid soils, resulting in them leaching through the soils and thus out of reach of plant roots. Furthermore, their solubility allows them to combine

with aluminium and iron cations, rendering the phosphates unavailable as iron and aluminium compounds.

The result is an immense loss of phosphates, since those that do not combine with aluminium, or are not effectively used by the plant roots, leach away due to high rainfall. These phosphates eventually find their way into the waterways of the country, thereby causing an excess of phosphate in these areas which, under certain climatic conditions, promotes the growth of blue-green algae and other undesirable water plant growth. It will be appreciated that there is a general tendency to over water in both large and small horticultural environments, increasing the problems of leaching and thus reducing the effectiveness of such fertilisers.

Consequently, the protein content of, for example, cereal grain crops has been shown to be reduced under the above described conditions. This decrease in efficacy means that extra fertiliser must be used to compensate for this loss, causing an increase in the financial burden to primary producers and other users, while at the same time exacerbating the situation by causing a further decrease in soil pH (i.e. increasing its acidity).

In order to reduce the acidity of acid soil types, lime has long been used separately from superphosphates in the treatment of such acid soils. Furthermore, it has been recognised that the use of lime in conjunction with superphosphate in such acid soils has the remarkable effect of greatly increasing the fertilising efficiency and absorption thereof by plants, especially leguminous plants, during their growing season.

For example, Australian Patent 127817 describes the use of a superphosphate/lime combination wherein the ratio of the mix is not less than 2 parts by weight of lime to 5 parts by weight of superphosphate. The efficacy of this fertiliser is further enhanced when the fertiliser is placed in drill rows in intimate contact with the seeds as sown or is at least concentrated in narrow bands of soil prior to sowing, rather than broadcast by conventional methods.

It has also been shown in various trials, in both government and private research institutions, that particle size plays a significant role in the availability of various nutrients to plant roots.

Furthermore, it should be understood that plants prefer a water insoluble but citrate soluble form of phosphate. This enables the plants to take up only their specific nutrient requirements, as and when needed, rather than as an infusion of nutrients which puts the plant system out of balance, thereby in fact reducing its growth potential.

By combining the benefits of a lime/superphosphate fertiliser with control over the particle size of the components, it has been surprisingly found that further previously unknown and unexpected benefits to crop growth may be had, compared with the use of conventional superphosphate. Thus, it is proposed by means of the present invention, to reduce the cost to the primary producer (and ultimately the end user) of using superphosphate fertiliser, whilst at the same time rehabilitating acid soils and thereby increasing crop yields having a higher quality produce.

An object of the present invention is therefore to increase the fertilising efficiency of superphosphates, particularly in acid conditions, by both the addition of lime and by producing the fertiliser in a form in which there has been provided specific control over the particle size of the components. Whilst the preferred form of the invention is a pellet, it will be understood that if required, this fertiliser can also be made in powder form for use in gardens, horticulture and the like. At the very least, the invention provides an alternative to presently proposed methods of employing superphosphate fertilisers.

According to one aspect of the present invention, there is provided a phosphatic fertiliser which comprises an intimate admixture of superphosphate and lime in the proportion of not less than one part by weight of lime to one part by weight of superphosphate, wherein prior to admixture, the particle size of superphosphate is reduced to below 250 microns and the particle size of lime is reduced to below 72 microns, admixture occurring in the dry state, after which water is then added to the mixture causing a chemical reaction between the lime and the superphosphate, such that on completion of the chemical reaction, the fertiliser contains phosphate which is substantially insoluble in water but which is citrate soluble and contains an excess of lime, the resulting fertiliser having a pH of not less than 7.

In this way superphosphate is effectively digested back into limestone with the result of converting soluble phosphates into their water insoluble or citrate soluble form.

Preferably, the fertiliser is formed into pellets utilising any suitable binder, or combination of binders, for example

a 2.5% sugar solution, for convenient storage and handling as well as deployment in seed sowing equipment. Upon entering the soil the pellet will break down presenting citrate soluble phosphates having a microcrystalline structure suitable for absorption by the plant roots.

Preferably the lime as used in the present invention is simply ground limestone ($CaCO_3$) which is also known as agricultural lime. However the lime referred to herein may in fact be any suitable form of lime including any one or more of the following (subject of course to its surface area, i.e. micron size, as herein defined):

quick lime or burnt lime (CaO)
builder's lime or slaked lime ($Ca(OH)_2$)
freshly air-slaked lime (CaO, $Ca(OH)_2$, $CaCO_3$)
very old completely air-slaked lime ($CaCO_3$) or
ground dolomite ($MgCO_3$, $CaCO_3$).

According to a further aspect of the invention, there is provided a method of producing a phosphatic fertiliser comprising the steps of:

1. reducing the particle size of a superphosphate to below 250μ and the particle size of a lime to below 72μ,

2. intimately admixing in the dry state the superphosphate and lime in the proportion of not less than one part by weight of lime to one part by weight of superphosphate, and

3. adding sufficient amount of water to the resulting mixture to produce a chemical reaction between the lime

and superphosphate, such that on completion of the chemical reaction, the fertiliser contains phosphate which is substantially water insoluble but which is citrate soluble and contains an excess of lime, the resulting fertiliser having a pH of not less than 7.

For example, very high quality calcium carbonate and/or magnesium carbonate are finely divided to such a degree so as to achieve 100% of the material passing a 72μ mesh. This has the effect of creating an immense surface area that can be worked on by the soil acids. Superphosphate (single super, double super and triple super) is also finely divided in the same manner to achieve 100% thereof passing a 250μ mesh.

Preferably, the process of the invention also includes the step of pelletising the resulting fertiliser. Alternatively the fertiliser may be prepared in powdered form.

According to a third aspect of the invention there is provided a continuous processing plant for producing an improved fertiliser according to the invention, comprising means for pulverising superphosphate and lime to the desired particle size as herein defined, means for metering and conveying said superphosphate and lime into a dry mixer, a reaction chamber to which the dry mixture is conveyed and where the mixture is caused to undergo chemical reaction which is initiated by the addition of water.

Preferably the plant also comprises a pelletiser to convert the fertiliser into pellet form.

Conveniently, the dry mixer consists of an auger having a

flight of appropriate design. More preferably the dry mixer is sealed to eliminate the possibility of dust escaping into the atmosphere and to avoid contamination or alteration of the carefully metered mixture.

The reaction chamber preferably consists of an auger or auger-like arrangement of suitable design to allow the mixture to be conveyed and continuously mixed as the reaction progresses. Preferably the reaction chamber comprises two contra rotating augers or auger-like members having minimum surface area, to reduce contact with the reaction mixture, but which allow forward movement of the mixture and provide a continuous mixing action.

With advantage the surfaces of such augers or auger-like members may be coated with a suitable wax to facilitate processing by reducing friction. Such a wax needs to withstand the heat of abrasion in the reaction zone.

The overall design of the reaction chamber needs to take into account that the mixture starts dry, initially reacts to form a soft viscous mud-like substance on the addition of water and then dries out again, leaving the reaction chamber as a slightly dampish powder to go to the pelletiser as required. Otherwise the powder may be simply left to dry as a powder.

Preferably the reaction chamber is provided with water sprays which allow a predetermined amount of water with additives as required, to be applied to the mixture at a predetermined pressure.

In order to test the efficacy of the fertiliser according to

the invention, amounts of superphosphate and lime in the following ratios were measured by weight. This method was repeated for various types of superphosphate in combination with either calcium carbonate (agricultural lime) or magnesium carbonate.

A	Superphosphate/lime	1:1
B	Superphosphate/lime	1:2
C	Superphosphate/lime	1:3
D	Superphosphate/lime	1:4

After being finely divided and weighed, both the superphosphate and lime were conveyed to a mixer. Water was then carefully measured into the mixture so as to allow a complete chemical reaction to occur resulting in a fertiliser having no water soluble phosphate, but only citrate soluble phosphate, and containing an excess of calcium carbonate in it.

The fertiliser was then conveyed from the mixer to the pelletiser where it was pelletised, during part of which time the chemical reaction continued to take place.

Upon leaving the pelletiser, the fertiliser passed through a screen that rejected the oversize pellets which were crushed and then returned to the pelletiser. The finished fertiliser that passed through the screen was conveyed to the finished product storage area where it stood and aged for a period of several days.

The fertiliser thus produced has been shown by experiment to be extremely effective when compared to conventional superphosphate application.

An embodiment of the invention will now be described by way

of example only with reference to Figure 1, which is a flow diagram of a plant for producing a fertiliser according to the invention.

The plant comprises three raw phosphate bins or silos 10 which contain various types and grades of superphosphate and the like, thus preventing contamination and the possibility of the respective phosphates absorbing moisture. Beneath each silo 10 there is a measuring and metering device 11 having an infinitely adjustable control, so as to allow an infinite variety of mixtures of the various superphosphates to be conveyed alone or together into the pulverising mill 12, where it is ground to less than 250μ.

The mixture of ground superphosphates is fed onto and conveyed by the conveyor 13 at a measured rate. Onto this is added a carefully metered amount of lime (limestone, dolomite or the like), ground to less than 72 μ, from silo 14, to which is also fitted a very accurate measuring or metering device 15.

Conveyor 13 feeds the measured amounts of ground superphosphate and ground lime, into the dry mixer 16 which consists of an auger having a flight of appropriate design. The mixer 16 is sealed to eliminate the possibility of dust escaping into the atmosphere and to avoid contamination or alteration of the carefully metered mixture. This dry mixer 16 travels at a speed determined by experimentation so as to thoroughly mix in the dry state the measured ingredients from silos 10 and 14. Since the dry mixer 16 is also effectively a conveying device as well as a mixing device, it conveys the mixture into the reaction chamber 17. The reaction chamber 17 consists of two specially designed,

contra-rotating auger-like members, which produce a mixing action together with a slow conveying action resulting in a specified amount of time (6 minutes) in which the reactants remain in the reaction chamber 17. The speed of the special auger-like mixing and conveying members may be altered by a speed controlling device built into the reaction chamber 17. Thus the speed of revolution of the auger-like members may be controlled as required so that the conveying speed of the fertiliser and hence the reaction time in the chamber, may be controlled.

The reaction of the previously dry mixed and measured ingredients is initiated by allowing water and any reagent aids (including binders for pelletising) to be introduced in a predetermined amount at a predetermined pressure through the reagent spray 18 which consists of a series of carefully designed sprays to ensure the most effective coverage of the dry mixture deposited into the reaction chamber 17.

After the reaction has been initiated between the separate ingredients of the improved fertiliser, the resulting mixture will have changed composition resulting in a damp granular consistency. It is then expelled from the reaction chamber 17 by the action of the auger-like members onto the conveyor 19.

Conveyor 19 carries the partly reacted improved fertiliser to a predetermined height (1m) where it drops onto the pelletiser 20 to be pelletised to a predetermined size and graded hardness.

The pelletiser 20 is of special design consisting of a disc some 3 metres in diameter rotating at a predetermined speed

of 11-13 r.p.m. and at a predetermined angle of between 45 and 55° to the normal. The improved fertiliser in its partly reacted form is thus subjected to a falling motion from conveyor 19, whereupon it strikes the rotating pelletiser 20 at an angle, where it is further subjected to a vertical rolling movement. This results in a reversal of direction for the dropping improved fertiliser, thus producing spherical granules or pellets. The resulting pellets remain on the pelletiser 20 until the build up is sufficient to allow them to overflow. After having been consolidated as granules or pellets, they overflow through the side of the pelletiser 20, designed for that purpose.

The pellets overflow onto a conveyor 21 from where they are conveyed into a rotating trummel sizing screen 22. Pellets which pass the screen 22 are conveyed by means of conveyor 23 to the finished product storage area 24. The finished fertiliser may age in storage where it stands for a period of several days, after which time it is then is available for distribution as required.

The improved fertiliser pellets that are too large to pass through the screen 22, are passed through a specially designed device 25 consisting of a number of flat steel plates rotating at a predetermined speed acting as a lump crusher, where the oversize pellets are pulverised back to a damp powder which is then returned via conveyor 26 and conveyor 19 to be again deposited onto the pelletiser 20 for re-pelletising.

Should the improved fertiliser be required as a granular powder instead of pellets, the process of pelletising is avoided thus resulting in production of a granular powder.

Any trace elements required may be conveniently added midway during the reactive stage to ensure that a thorough blending of the additives occurs.

An additional advantage provided by the invention is that it allows the pelletised improved fertiliser to be incorporated with the seed of grain crops (such as wheat, barley and the like) so that they are planted together utilising seed drills in accordance with current technology. This can provide a saving of up to 900% over traditional spreading methods such as broadcasting.

As reported in many published papers, it has been found that up to 75% of the phosphates in superphosphate leach below the plant rizobiosphere, or root area, in the soil during the year of application thus leaving only 25% of the 9% available phosphate contained in single superphosphate available to the crop. The fertiliser according to this invention will arrest this leaching process and will make available 95% of the applied phosphate.

It will thus be appreciated that the pelletised improved fertiliser provides unique benefits and has a wide application in all countries, particularly those with acid soils or with high rainfalls that cause heavy leaching of conventional fertilisers.

The benefits of this fertiliser may be summarised as follows:

It has a very large surface area for immediate absorption into the soil.

Up to 95% of the applied phosphate in the form of water

insoluble phosphates, which are citrate soluble, are made available to the plant roots.
The possibility of leaching is arrested.
The pelletised fertiliser has the capacity to be handled easily with conventional planting equipment.

Therefore, a very wide application at a very economical rate is to be had by farmers, worldwide, in virtually every agricultural and horticultural endeavour.

From the foregoing it will be readily appreciated that numerous modifications and variations can be effected without departing from the true spirit and scope of the invention. It will be understood that no limitation with respect to the specific embodiments described herein is intended or should be inferred.

THE CLAIMS DEFINING THIS INVENTION ARE AS FOLLOWS:

1. A phosphatic fertiliser comprising an intimate admixture of superphosphate and lime in the proportion of not less than one part by weight of lime to one part by weight of superphosphate, wherein prior to admixture, the particle size of superphosphate is reduced to below 250 microns and the particle size of lime is reduced to below 72 microns, admixture occurring in the dry state, after which water is then added to the mixture causing a chemical reaction to occur between the lime and superphosphate, such that on completion of the chemical reaction, the fertiliser contains phosphate which is substantially insoluble in water but which is citrate soluble and contains an excess of lime, the resulting fertiliser having a pH of not less than 7.

2. The fertiliser according to claim 1, formed into pellets utilising any suitable binder, or combination of binders.

3. The fertiliser according to claim 2, in which the binder is a 2.5% sugar solution.

4. The fertiliser according to any one of claims 1 to 3, in which the lime is selected from amongst ground limestone or agricultural lime; quick lime or burnt lime; builder's lime or slaked lime; freshly air-slaked lime; very old completely air-slaked lime; and ground dolomite.

5. A method of producing a phosphatic fertiliser

comprising the steps of:

a. reducing the particle size of a superphosphate to below 250μ and the particle size of a lime to below 72μ,

b. intimately admixing in the dry state the superphosphate and lime in the proportion of not less than one part by weight of lime to one part by weight of superphosphate, and

c. adding a sufficient amount of water to the resulting mixture to cause a chemical reaction between the lime and the superphosphate, such that on completion of the chemical reaction, the fertiliser contains phosphate which is substantially water insoluble but which is citrate soluble and contains an excess of lime, the resulting fertiliser having a pH of not less than 7.

6. A method of producing a phosphatic fertiliser according to claim 5, in which there is an additional step of pelletising the resulting fertiliser, by utilising a suitable binder.

7. A method according to either claim 5 or claim 6, in which the lime used is selected from amongst ground limestone or agricultural lime; quick lime or burnt lime; builder's lime or slaked lime; freshly air-slaked lime; very old completely air-slaked lime; and ground dolomite.

8. A continuous processing plant for producing an improved phosphatic fertiliser according to any one of claims 1 to 4, comprising means for pulverising the

superphosphate and lime to the desired particle size, means for metering and conveying said superphosphate and lime into a dry mixer, and a reaction chamber to which the dry mixture is transferred and where the mixture is caused to undergo chemical reaction initiated by the addition of water.

9. A processing plant according claim 8, further comprising a pelletiser for the optional conversion of reacted fertiliser into pellet form.

10. A processing plant according to either claim 8 or claim 9, in which the dry mixer consists of an auger having a flight of appropriate design to allow mixing of lime and superphosphate and transferral thereof to the reaction chamber.

11. A processing plant according to any one of claims 8 to 10, in which the dry mixer is sealed to eliminate the possibility of dust escaping into the atmosphere and to avoid contamination of the lime or superphosphate mixture.

12. A processing plant according to any one of claims 8 to 11, in which the reaction chamber consists of an auger or auger-like arrangement of suitable design to allow the mixture to be conveyed and continuously mixed as the reaction progresses.

13. A processing plant according to claim 12, in which the reaction chamber comprises two contra rotating augers or auger-like members having minimum surface area, in order to reduce contact with the reaction

mixture, but which allow the mixture to be conveyed and provide the continuous mixing action.

14. A processing plant according to either claims 12 or claim 13, in which the surfaces of such augers or auger-like arrangements are coated with a suitable wax to facilitate processing by reducing friction.

15. A processing plant according to any one of claims 8 to 14, in which the reaction chamber is provided with water sprays which allow a predetermined amount of water with additives as required, to be applied to the mixture at a predetermined pressure to initiate the reaction.

16. A phosphatic fertiliser substantially as described herein.

17. A method for producing a phosphatic fertiliser substantially as described herein in conjunction with Fig. 1.

18. A processing plant for producing a phosphatic fertiliser substantially as described herein in conjunction with Fig. 1.

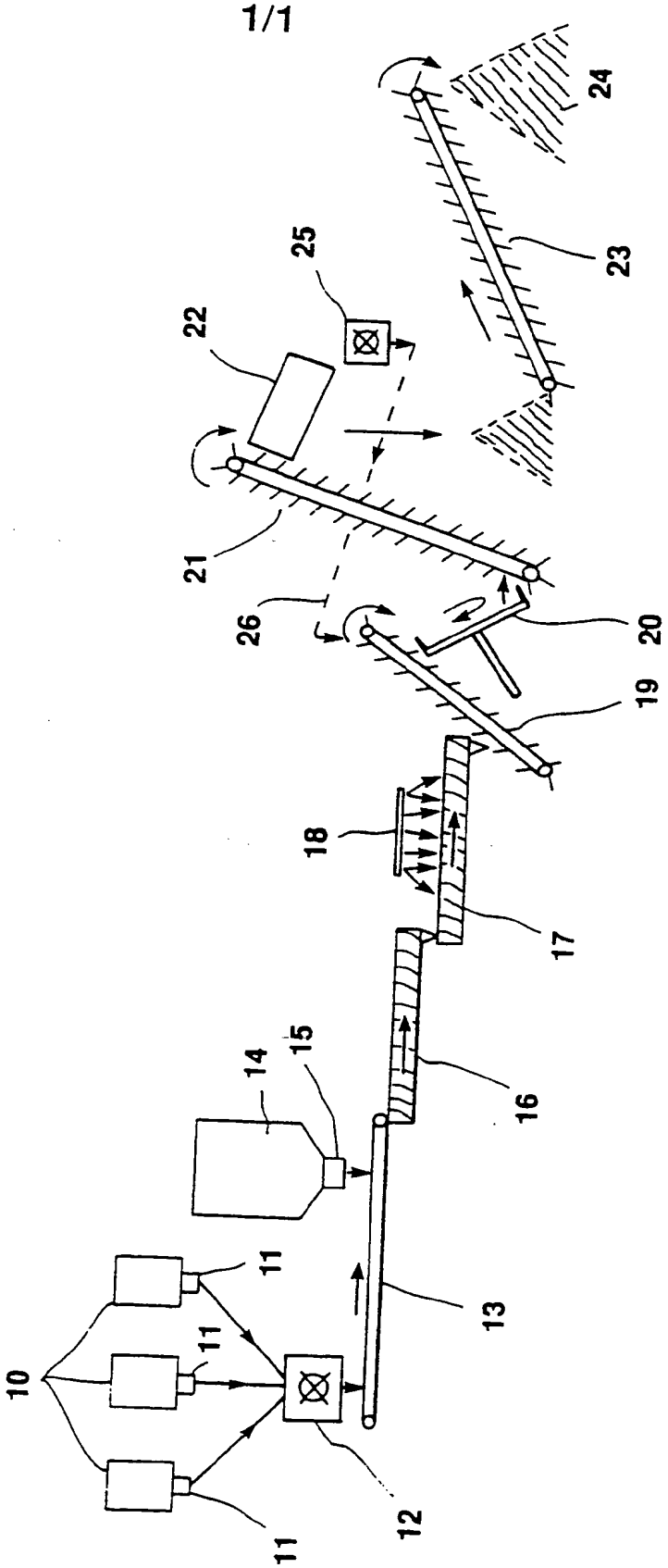

FIGURE 1

INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent classification (IPC) or to both National Classification and IPC

Int. Cl.[5] C05G 1/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	C05G 1/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

AU : IPC as above; Australian Classification 31.7

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category*	Citation of Document, [11] with indication, where appropriate of the relevant passages [12]	Relevant to Claim No [13]
X	AU, B, 20813/53 (163825) (H.A.J. PITTMAN and W.H. ANDERSON 22 July 1954 (22.07.54)	(1-7, 16-17)
X	AU, B, 17203/44 (127817) (H.A.J. PITTMAN and W.H. ANDERSON) 3 June 1948 (03.06.48). In particular see page 6.	(1-7, 16-17)
X	AU, A, 13066/88 (NATUMIX FERTILISERS LTD) 22 September 1988 (22.09.88). Whole document. In particular see page 3.	(1-7, 16-17)
A	US, A, 1855190 (KERN) 26 April 1932 (26.04.32)	
A	US, A, 1953419 (MACINTIRE) 3 April 1934 (03.04.34)	

Continued...

* Special categories of cited documents : [10]

"A" Document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior t the international filing date but later than the priority date claimed

"T" Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1 May 1992 (01.05.92)	5 May 1992 (05.05.92)
International Searching Authority	Signature of Authorized Officer
AUSTRALIAN PATENT OFFICE	C.A. BRICK

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	US, A, 2348343 (HOLBROOK) 9 May 1944 (09.05.44)	

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ..., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4a

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL APPLICATION NO. PCT/AU 92/00022

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mention d international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member				
AU 20813/53					
AU 13066/88	NZ	220019	NZ	219729	
US 1953419					
US 2348343					
AU 17203/44					
US 1855190					